poster ABSTRACT

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TITLE

Evaluation of Alternative Methods for Characterizing Air Quality to Estimate Population Exposures—Wisconsin

THEME

Advance Environmental Public Health Science and Research

KEYWORDS

cardiovascular disease, air pollution

BACKGROUND

Five percent of six million annual hospital admissions for cardiovascular disease in the U.S. can be attributed to airborne particulate matter (PM2.5). Understanding the relation between cardiovascular disease and PM2.5 is difficult due to the lack of ability to accurately assess exposure. The most commonly used method of assigning exposure to individuals or populations in research studies is proximity to air monitors. Monitors provide information for one geographic location; however, very few monitors provide daily PM2.5 measurements, creating temporal gaps; furthermore, few monitors are located in rural areas, creating spatial gaps. There are several methods that can potentially fill these temporal and spatial gaps but they have not been explored for their utility as part of public health surveillance. The purpose of this study is to evaluate three air quality characterization methods—kriging, Community Multi-Scale Air Quality (CMAQ), and Hierarchical Bayesian—to determine which of the three methods is the most valid and reliable relative to monitor observations and the referent method for assigning exposure (monitor proximity).

OBJECTIVE(S)

1) To evaluate the relative validity of the three methods by comparing PM2.5 concentration estimates to measurements obtained from monitors; and 2) To assess the validity and reliability of using these three methods to assign exposure classification using monitor proximity as the referent standard.

METHOD(S)

36km grid cells were used to estimate a daily average county-wide PM2.5 concentration estimate for six Wisconsin counties selected to represent urban and rural areas, different areas of the state, and counties with and without monitors. Measures of validity—means, standard deviation, means difference, and correlation—were calculated to compare concentration estimates obtained from using each of the three methods to the monitor measures. To compare exposure classifications of the three methods, monitor proximity was set as the referent standard. Cardiovascular disease hospitalization cases were aggregated at the county level on a daily basis for the year 2001 using the case definition of ischemic heart disease, congestive heart failure, cerebrovascular disease (stroke) admissions, principle diagnosis only (ICD-9-CM: 410-414, 428, 430-438). The average of all monitoring sites for each day in 2001 was used to calculate a daily monitor measurement for PM2.5. Exposure was dichotomized using the Air Quality Index (AQI) to reflect "healthy" $\leq 40.4 \mu g/m^3$ and "unhealthy" $>40.4 \mu g/m^3$. Using monitor proximity and the three methods, cardiovascular cases were assigned an exposure concentration on the day of hospitalization. Measures of validity (sensitivity, specificity,

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positive predicted value, and negative predicted value) and reliability (percent agreement and kappa coefficient) were calculated.

RESULT(S)

All of CMAQ means differences were statistically significant; means differences for kriging were statistically significant in all counties except for Bayfield; and 3 of 6 means differences for Hierarchical Bayesian were significant—Milwaukee, Bayfield, and Douglas Counties. The correlation between 1) kriging estimates and monitor observations ranged from 0.77 to 0.93; 2) CMAQ estimates and monitor observations ranged from 0.72 to 0.80; and, 3) Hierarchical Bayesian estimates and monitor observations ranged from 0.72 to 0.98. Only Milwaukee County had sufficient number of cases to be analyzed for validity and reliability measures for exposure assignment.

Validity measures for: 1) Kriging—sensitivity, undefined; specificity, 100%; PPV, undefined; NPV, 99.2%; 2) CMAQ—sensitivity, 75%; specificity, 98.3%, PPV, 27.3%; and NPV, 99.8%; 3) Hierarchical Bayesian—sensitivity, 0%; specificity, 99.7%; PPV, 0%; NPV, 99.2%. Reliability measures for: 1) Kriging—percent agreement, 99.2%; and, K=0; 2) CMAQ—percent agreement, 98.1%; and, K=0.39; 3) Hierarchical Bayesian—percent agreement, 98.9%; and, K=-$4.36x10^{-03}$.

The findings of this study suggest that of the three methods, CMAQ is the least valid (but still moderate) when comparing concentration estimates to monitor measures, but that CMAQ is the most valid and reliable for assigning exposure relative to the referent method (monitor proximity). Utility for use in public health will ultimately be determined by the ability of the method to detect an association between exposure to PM2.5 and cardiovascular disease.

DISCUSSION/RECOMMENDATION(S)

We recommend further comparisons between the methods to assess cost, availability, ease of use, etc. Also, the methods may differ significantly at more resolved geographic scales. Additional analyses should be performed at lower levels of aggregation such as zip code or census tract. Additionally, no threshold (or at least none above 20$\mu g/m^3$) has been found in studies of acute effects of PM2.5. Additional classification comparisons of the three air characterization methods may also need to be performed with more exposure categories (i.e., unexposed, low, medium, high).

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